

JC03 Rec'd PCT/PTO 21 JUN 2001
09/ 868945IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
REQUEST FOR FILING NATIONAL PHASE OF
PCT APPLICATION UNDER 35 U.S.C. 371 AND 37 CFR 1.494 OR 1.495Commissioner of Patents
Washington, D.C. 20231

00909

TRANSMITTAL LETTER TO THE UNITED STATES
DESIGNATED/ELECTED OFFICE (DO/EO/US)Atty Dkt: P 281188 /381REG/701554US
M# /Client Ref.

Date: June 21, 2001

From: Pillsbury Winthrop LLP, IP Group:

This is a **REQUEST** for **FILING** a PCT/USA National Phase Application based on:

1. International Application

2. International Filing Date

3. Earliest Priority Date Claimed

PCT/US99/29992

17 December 1999

21 December 1998

country code

Day MONTH Year

Day MONTH Year
(use item 2 if no earlier priority)

4. Measured from the earliest priority date in item 3, this PCT/USA National Phase Application Request is being filed within:

(a) ☐ 20 months from above item 3 date (b) ☒ 30 months from above item 3 date,

(c) Therefore, the due date (unextendable) is June 21, 2001

5. Title of Invention LOW PRESSURE COMPRESSION MOLDED PARTS HAVING NANO-PARTICLE REINFORCED PROTRUSIONS AND METHOD OF MAKING THE SAME6. Inventor(s) WILSON, Phillip S.

Applicant herewith submits the following under 35 U.S.C. 371 to effect filing:

7. ☒ Please immediately start national examination procedures (35 U.S.C. 371 (f)).8. ☒ A copy of the International Application as filed (35 U.S.C. 371(c)(2)) is transmitted herewith (file if in English but, if in foreign language, file only if not transmitted to PTO by the International Bureau) including:a. ☒ Request;b. ☒ Abstract;

c. 18 pgs. Spec. and Claims;

d. 4 sheet(s) Drawing which are ☐ informal ☒ formal of size ☒ A4 ☐ 11"9. ☒ A copy of the International Application has been transmitted by the International Bureau.

10. A translation of the International Application into English (35 U.S.C. 371(c)(2))

a. ☐ is transmitted herewith including: (1) ☐ Request; (2) ☐ Abstract;

(3) pgs. Spec. and Claims;

(4) sheet(s) Drawing which are:

☐ informal ☐ formal of size ☐ A4 ☐ 11"b. ☒ is not required, as the application was filed in English.c. ☐ is not herewith, but will be filed when required by the forthcoming PTO Missing Requirements Notice per Rule 494(c) if box 4(a) is X'd or Rule 495(c) if box 4(b) is X'd.d. ☐ Translation verification attached (not required now).

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11. ☒ Please see the attached Preliminary Amendment
12. ☐ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3)), i.e., before 18th month from first priority date above in item 3, are transmitted herewith (file only if in English) including:
13. ☒ PCT Article 19 claim amendments (if any) have been transmitted by the International Bureau
14. ☐ Translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)), i.e., of claim amendments made before 18th month, is attached (required by 20th month from the date in item 3 if box 4(a) above is X'd, or 30th month if box 4(b) is X'd, or else amendments will be considered canceled).

15. **A declaration of the inventor** (35 U.S.C. 371(c)(4))

- a. ☒ is submitted herewith ☐ Original ☒ Facsimile/Copy
- b. ☐ is not herewith, but will be filed when required by the forthcoming PTO Missing Requirements Notice per Rule 494(c) if box 4(a) is X'd or Rule 495(c) if box 4(b) is X'd.

16. **An International Search Report (ISR):**

- a. Was prepared by ☒ European Patent Office ☐ Japanese Patent Office ☐ Other
- b. ☒ has been transmitted by the international Bureau to PTO.
- c. ☒ copy herewith (2 pg(s).) ☒ plus Annex of family members (1 pg(s).).

17. **International Preliminary Examination Report (IPER):**

- a. ☒ has been transmitted (if this letter is filed after 28 months from date in item 3) in English by the International Bureau with Annexes (if any) in original language.
- b. ☒ copy herewith in English.
- c.1 ☒ IPER Annex(es) in original language ("Annexes" are amendments made to claims/spec/drawings during Examination) including attached amended:
- c.2 ☒ Specification/claim pages # 1 claims # _____
Dwg Sheets # _____
- d. ☐ Translation of Annex(es) to IPER **(required by 30th month due date, or else annexed amendments will be considered canceled).**

18. **Information Disclosure Statement** including:

- a. ☒ Attached Form PTO-1449 listing documents
- b. ☒ Attached copies of documents listed on Form PTO-1449
- c. ☒ A concise explanation of relevance of ISR references is given in the ISR.

19. ☒ **Assignment** document and Cover Sheet for recording are attached. Please mail the recorded assignment document back to the person whose signature, name and address appear at the end of this letter.

20. ☐ Copy of Power to IA agent.

21. ☐ **Drawings** (complete only if 8d or 10a(4) not completed): _____ sheet(s) per set: ☐ 1 set informal;
☐ Formal of size ☐ A4 ☐ 11"

22. Small Entity Status ☒ is **Not** claimed ☐ is claimed (pre-filing confirmation required)
- 22(a) _____ (No.) Small Entity Statement(s) enclosed (since 9/8/00 Small Entity Statements(s) not essential to make claim)

23. **Priority** is hereby claimed under 35 U.S.C. 119/365 based on the priority claim and the certified copy, both filed in the International Application during the international stage based on the filing in (country) United States of:

	Application No.	Filing Date		Application No.	Filing Date
(1)	60/113,133	21 December 1998	(2)	_____	_____
(3)	_____	_____	(4)	_____	_____
(5)	_____	_____	(6)	_____	_____

- a. ☒ See Form PCT/IB/304 sent to US/DO with copy of priority documents. If copy has not been received, please proceed promptly to obtain same from the IB.
- b. ☐ Copy of Form PCT/IB/304 attached.

24. Attached:

09/868945
JC18 Rec'd PCT/PTO 21 JUN 200125 Per Item 17.c2, **cancel original** pages # _____, claims # _____, Drawing Sheets # _____26. **Calculation of the U.S. National Fee (35 U.S.C. 371 (c)(1)) and other fees is as follows:**Based on amended claim(s) per above item(s) ☐ 12, ☐ 14, ☐ 17, ☐ 25 (hills)

Total Effective Claims	10	minus 20 =	0	x \$18/\$9	=	\$0	966/967
Independent Claims	2	minus 3 =	0	x \$80/\$40	=	\$0	964/965
If any proper (ignore improper) Multiple Dependent claim is present,				add \$270/\$135	=	+0	968/969

BASIC NATIONAL FEE (37 CFR 1.492(a)(1)-(4)): →→ **BASIC FEE REQUIRED, NOW** →→→→A. If country code letters in item 1 are **not** "US", "BR", "BB", "TT", "MX", "IL", "NZ", "IN" or "ZA" ↓

See item 16 re: ↓

1. Search Report was <u>not</u> prepared by EPO or JPO -----	add \$1000/\$500	960/961
2. Search Report was prepared by EPO or JPO -----	add \$860/\$430 +0	970/971

SKIP B, C, D AND E UNLESS country code letters in item 1 are "US", "BR", "BB", "TT", "MX", "IL", "NZ", "IN" or "ZA" ↓

→ <input checked="" type="checkbox"/> B. If USPTO did not issue both International Search Report (ISR) and (if box 4(b) above is X'd) the International Examination Report (IPER), -----	add \$1000/\$500	+1000	960/961
(only) → <input type="checkbox"/> C. If USPTO issued ISR but not IPER (or box 4(a) above is X'd), -----	add \$710/\$355	+0	958/959
(one) → <input type="checkbox"/> D. If USPTO issued IPER but IPER Sec. V boxes <u>not all</u> 3 YES, -----	add \$690/\$345	+0	956/957
(of) → <input type="checkbox"/> E. If international preliminary examination fee was paid to USPTO and Rules 492(a)(4) and 496(b) <u>satisfied</u> (IPER Sec. V <u>all</u> 3 boxes YES for <u>all</u> claims), -----	add \$100/\$50	+0	962/963

27. **SUBTOTAL =** \$1000

28. If Assignment box 19 above is X'd, add Assignment Recording fee of ---\$40 +40 (581)

29. Attached is a check to cover the ----- **TOTAL FEES** \$1040

Our Deposit Account No. 03-3975

Our Order No. 81548 281188

C# M#



00909

CHARGE STATEMENT: The Commissioner is hereby authorized to charge any fee specifically authorized hereafter, or any missing or insufficient fee(s) filed, or asserted to be filed, or which should have been filed herewith or concerning any paper filed hereafter, and which may be required under Rules 16-18 and 492 (missing or insufficient fee only) now or hereafter relative to this application and the resulting Official document under Rule 20, or credit any overpayment, to our Account/Order Nos. shown above for which purpose a duplicate copy of this sheet is attached.

This CHARGE STATEMENT does not authorize charge of the issue fee until/unless an issue fee transmittal form is filedPillsbury Winthrop LLP
Intellectual Property Group

By Atty: Jack S. Barufka

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NOTE: File in duplicate with 2 postcard receipts (PAT-103) & attachments.

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JC18 Rec'd PCT/PTO 21 JUN 2001

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re PATENT APPLICATION OF

Inventor(s): WILSON, Phillip S.

Filed: Herewith

Title: LOW PRESSURE COMPRESSION MOLDED PARTS HAVING NANO-PARTICLE
REINFORCED PROTRUSIONS AND METHOD OF MAKING THE SAME

June 21, 2001

PRELIMINARY AMENDMENTHon. Commissioner of Patents
Washington, D.C. 20231

Sir:

Please amend this application as follows:

IN THE SPECIFICATION:

At the top of the first page, just under the title, insert

☒ --This application is the National Phase of International Application
PCT/US99/29992 filed 17 December 1999 which designated the U.S.
and that International Application

☒ was ☐ was not published under PCT Article 21(2) in English.--

Respectfully submitted,

PILLSBURY WINTHROP LLP
Intellectual Property GroupBy: 

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LOW PRESSURE COMPRESSION MOLDED PARTS HAVING
NANO-PARTICLE REINFORCED PROTRUSIONS
AND METHOD OF MAKING THE SAME

5 BACKGROUND OF THE INVENTION

Automobile interior trim is often engineered to minimize wall thickness, while maintaining desired structural characteristics. Greater wall thickness of such molded articles requires more raw material per unit part, thereby undesirably increasing the cost of production and increasing vehicle weight. Furthermore, greater wall
10 thicknesses slow down production time due to longer cycling periods needed to permit cooling of thicker molded regions.

Automotive trim components or articles, such as interior panels are often molded from thermoplastic to have various protrusions extending from a broad panel surface, which protrusions serve different functions. For example, some trim components are
15 provided with stiffening ribs to reduce twisting or flexing of the part. The same or other trim components may be provided with fastening bosses that add rigidity and/or strength to areas of the part that are to be secured or fastened to another structure. For example, a screw receiving hole in a molded article may be surrounded by an annular protrusion for support. Such annular protrusion may also have radially outwardly extending
20 protrusions (as an asterisk) to provide further support. As another example, standoffs may be formed on the broad surface of the part to provide proper spacing from an abutting component. As a further example, a protrusion may be in the form of a dog house or cage, which is used to secure the article or trim component to some other part, e.g., by a hook.

Because it is desirable to manufacture automotive parts with the least amount of material as possible, without sacrificing performance, it is desirable to make the types of protrusions mentioned above as small as possible, so long as they achieve their intended function. Oftentimes, it is desirable to make the protrusions with a thickness of 1/10" or less (i.e., measured in a direction parallel to the surface from which the protrusion protrudes and perpendicular to the longitudinal direction of the protrusion).

It can be appreciated that protrusions of such narrow cross section may be subject to chipping or breakage. As the protrusion protrudes further from the base surface, it becomes more prone to breakage. In addition, several of such protrusions are of a tapered configuration terminating in a relatively narrow pointed tip. Such tip is often less than 1/10" thick and is highly prone to chipping.

Of course, almost all thermoplastic automotive trim components are reinforced by reinforcement materials. More specifically, it is known to use glass fibers to reinforce thermoplastic trim components. Such glass fibers typically have a length on the order of about 1/8". When glass-reinforced thermoplastic materials are molded in high pressure injection molding operations (e.g., of pressure levels greater than 15,000 PSI), movement of the molten material, for example, through a gate and runner system, causes the glass fibers to align themselves longitudinally with the longitudinal or longer extent of the projection. In this manner, even though the glass fibers have a length greater than the thickness of the protrusions, the thickness or width of the aligned fibers (typically about 6-20 microns) will fit into the protrusions to reinforce the protrusions adequately.

However, for certain applications, it is desirable to mold the thermoplastic articles in a low pressure compression molding method (e.g., less than 3,000 PSI). In such method, molten thermoplastic is introduced into a cavity. The mold is then

closed, and excess material is squeezed between the die surfaces so that the molten material fills all gaps and shapes to form the part. The part can thus be finished in a one-step process.

One drawback with the conventional low pressure compression molding methods, however, is that where a part is to be highly reinforced, e.g., requiring 25-35% by volume glass fibers, the glass reinforcement fibers inhibit substantial flow of molten material. As a result, the fibers do not align with the longitudinal direction of the protrusions, and an insufficient amount of glass fibers will enter into protrusions of thicknesses of 1/10" or less. Thus, these protrusions would need to be made thicker, or otherwise not be reinforced to the extent desirable.

It is an object of the invention to provide a highly reinforced molded part that can be provided with equally reinforced protrusions of a thickness less than 0.1". In order to achieve this object and to overcome the problems noted above, the present invention provides a reinforced molded article comprising a main portion which has opposing major surfaces defining a thickness of the main portion. A protrusion is integrally molded with the main portion and protrudes from one of the surfaces, the protrusion having a thickness of less than the thickness of the main portion and less than about 0.1". The protrusion has a height of at least twice the thickness of the protrusion. The main portion and the protrusion are formed from a material comprising at least one thermoplastic, and about 2% to about 15%, by volume, of reinforcing particles. The particles each comprise one or more layers, wherein at least 50% of the reinforcing particles are less than about 20 layers thick, at least 99% of the reinforcing particles are less than about 30 layers thick, and the layers comprise platelets having a thickness of between about 0.7 nm and 1.2 nm.

It is a further object of the invention to provide a method of manufacturing a highly reinforced molded part that has the equally reinforced protrusions as discussed above. In accordance with this object, the present invention provides a method of producing a reinforced article comprised of a main portion which has opposing major surfaces defining a thickness of the main portion. A protrusion is integrally molded with the main portion and protrudes from one of the surfaces, the protrusion having a thickness of less than the thickness of the main portion and less than about 0.1". The protrusion has a height of at least twice the thickness of the protrusion. The method prepares a melt of at least one thermoplastic, and about 2% to about 15%, by volume, of reinforcing particles. The particles each comprise one or more layers. At least 50% of the reinforcing particles are less than about 20 layers thick, at least 99% of the reinforcing particles are less than about 30 layers thick, and the layers comprise platelets having a thickness of between about 0.7 nm and 1.2 nm. The melt is compressed between die surfaces at a pressure of less than 3,000 PSI, the die surfaces having recesses corresponding to the shape of the protrusions and receiving the melt, including the 2%-15% by volume reinforcing particles, in the recesses so that the melt conforms to the shape of the recesses. The melt is cooled, and the cooled portions of the melt that are received in the recesses form the reinforced protrusions.

These and other objects of the invention can be more fully appreciated from the following detailed description of the preferred embodiments.

BRIEF DESCRIPTION OF THE DRAWINGS

A preferred embodiment of the present invention is described herein with reference to the drawings wherein:

FIG. 1 is a front elevation view of an inner door panel for a motor vehicle manufactured in accordance with the principles of the present invention;

FIG. 2 is a cross sectional view of a compression molding die assembly used in accordance with the method of the present invention;

FIG. 3 is a perspective view, partly in cross-section, of a reinforced article manufactured in accordance with the principles of the present invention;

FIG. 4. Is a perspective view, partly in cross-section, of another embodiment of a reinforced article manufactured in accordance with the principles of the present invention;

FIG. 5 is a cross sectional view of a compression molding die assembly used in accordance with another embodiment of the method of the present invention; and

FIG. 6 is a cross sectional view of a compression molding die assembly used in accordance with another embodiment of the method of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Shown in Fig. 1. is an inner door panel for a motor vehicle, generally indicated at 10, and used to exemplify certain applications of the present invention. In Fig. 1, several projections are illustrated schematically by the use of dashed lines.

For example, a plurality of stiffening ribs 12 are shown to add stiffness and rigidity to the panel 10, to inhibit bending, flexing or twisting of the panel. Also illustrated are an array of projections 14, which are used as structural supports for mounting a stereo speaker. This same region is provided with a plurality of bosses 16, which provide supported or reinforced holes through the panel 10, which hold or receive fasteners for affixing the speaker to the panel 10. Also shown are a plurality

of dog houses (also known as "cages") 18, known in the art to be used for securing other structures to the panel 10.

Fig. 2 is a partial cross-sectional view taken through a compression molding apparatus used to form the articles in accordance with the present invention. The apparatus, generally indicated at 20, includes a first die structure 22 and a second die structure 24. The die structures 22 and 24 have interior die surfaces 26 and 28, respectively, defining the shape of a die cavity corresponding to the shape of the article to be molded.

A plastic melt 30, to be described in greater detail later, is deposited between the die surfaces 26 and 28 (e.g., on the lower die surface 28 as illustrated in Fig. 2).

The surface 26 of the first die structure 22 defines a recess 32, which recess is used to form projections in accordance with the present invention.

After the melt 30 is provided between the die surfaces 26, 28, the die surfaces are moved towards one another (e.g., by moving die structure 22 downwardly towards die structure 24). Typically, peripheral portions of the die structures 22, 24 are brought into engagement with one another, leaving a die cavity between the central portions of die structures 22, 24. A sufficient amount of plastic melt 30 is provided between the die structures 22, 24 to fill the entire cavity completely, including any recesses 32, which are used to form the projections in accordance with the present invention.

It should be appreciated that the present invention concerns applications wherein a projection which is to be formed as a wall thickness of 0.1" or less. Therefore, it should be appreciated that the thickness (t) of the recess 32, which forms the projection in accordance with the present invention, should also be less than 0.1" thick.

In the compression molding method, any excess plastic material 30 is controllably squeezed out from between the surfaces 26, 28 and the die cavity into receiving ports. The die cavity is maintained at pressures less than 3,000 PSI during the molding operation.

Fig. 3 is a partial perspective view, partly in section, of an article 40 manufactured in accordance with the present invention. For example, this article 40 may be the door panel 10 illustrated in Fig. 1. As shown in Fig. 3, the article 40 comprises a main portion 42 having opposing major surfaces 44 and 46. Preferably, surfaces 44 and 46 are substantially parallel to one another. The surfaces 44 and 46 define a thickness (a) of the main portion 42. A protrusion 50 (e.g., which may form a stiffening rib 12 in Fig. 1) is integrally molded with the main portion 42 and protrudes from surface 44. The protrusion 50 has a thickness (t), which is less than the thickness (a) of the main portion 42. In addition, the thickness (t) is less than about 0.1". The protrusion 50 has a height (h) of at least twice the thickness (t) of the protrusion. The height (h) is at least twice the thickness (a) of the main portion 42.

As will be described in greater detail, the plastic melt 30, and hence, the integrally molded main portion 42 and protrusion 50 (shown in Fig. 3 after being removed from the die structure 20 and cooled), are formed from a material comprising at least one thermoplastic, and about 2% to about 15% by volume of reinforcing particles. The reinforcing particles each comprise one or more layers, and at least 50% of the reinforcing particles are less than about 20 layers thick. The layers comprise platelets having a thickness of between about 0.7 nm – 1.2 nm.

It is desirable for the thickness (t) of the protrusion 50 to be thinner than the main portion 42 so as to avoid the occurrence of a sink forming on the opposite surface 46 in the region thereof opposite the protrusion 50. The occurrence of this

sink may occur during cooling of the material 30 where the protrusion 50 comprises a significant amount of material and would therefore shrink to a significant extent, drawing material from the main portion 42 during cooling. It is preferred for the thickness (t) of the protrusion 50 to have a thickness of less than 80% of the thickness (a) of the main portion 42.

In order for the protrusion 50 to provide a sufficient amount of support for the main portion 42, the height (h) is at least twice the thickness (a) of the base portion 42.

Preferably, the minimum thickness (a) of the base portion 42 is .065".

Therefore, the minimum height (h) of the protrusion 50 is about .130".

It should be appreciated, however, that the dog houses (or cages) 18 in Fig. 1 can comprise projections over 1" in height. The cylindrical sleeves of the screw bosses 16 are preferably between ¼" to 1" in height.

Preferably, the height (h) of the protrusion 50 is between 2 times to 30 times the thickness (t) of the protrusion 50.

Irrespective of the fact that the thickness (t) of the protrusion 50 is less than 0.1", it is nevertheless reinforced to the same extent as the main portion 42, and to a greater extent than would be possible with high glass fiber loading. This is due to the particular nature of the molded material 30 used in accordance with the present invention as described below.

The articles (and the plastic melt from which the articles are molded) comprise a composite material of a polymer having dispersed therein reinforcement fillers in the form of very small mineral reinforcement particles. The reinforcement filler particles, also referred to as "nanoparticles" due to the magnitude of their dimensions, each comprise one or more essentially flat platelets. Generally, each platelet has a

thickness of between about 0.7-1.2 nanometers. The average platelet thickness is approximately 1 nanometer.

The preferred aspect ratio of the reinforcement particles, which is the largest dimension of a particle divided by the thickness of the particle, is about 50 to about 300. At least 80% of the particles should be within this range. If too many particles have an aspect ratio above 300, the material becomes too viscous for forming parts in an effective and efficient manner. If too many particles have an aspect ratio of smaller than 50, the particle reinforcements will not provide the desired reinforcement characteristics. More preferably, the aspect ratio for each particle is between 100-200. Most preferably at least 90% of the particles have an aspect ratio within the 100-200 range.

The platelet particles or nanoparticles are derivable from larger layered mineral particles. Any layered mineral capable of being intercalated may be employed in the present invention. Layered silicate minerals are preferred. The layered silicate minerals that may be employed include natural and artificial minerals. Non-limiting examples of more preferred minerals include montmorillonite, vermiculite, hectorite, saponite, hydrotalcites, kanemite, sodium octosilicate, magadite, and kenyaite. Mixed Mg and Al hydroxides may also be used. Various other clays can be used, such as claytone H.Y. Among the most preferred minerals is montmorillonite.

To exfoliate the larger mineral particles into their constituent layers, different methods may be employed. For example, swellable layered minerals, such as montmorillonite and saponite are known to intercalate water to expand the inter layer distance of the layered mineral, thereby facilitating exfoliation and dispersion of the layers uniformly in water. Dispersion of layers in water is aided by mixing with high shear. The mineral particles may also be exfoliated by a shearing process in which the

mineral particles are impregnated with water, then frozen, and then dried. The freeze dried particles are then mixed into molten polymeric material and subjected to a high sheer mixing operation so as to peel individual platelets from multi-platelet particles and thereby reduce the particle sizes to the desired range.

5 The polymer composites of the present invention are prepared by combining the platelet mineral with the desired polymer in the desired ratios. The components can be blended by general techniques known to those skilled in the art. For example, the components can be blended and then melted in mixers or extruders. The ratios will be determined based on, for example, desired dimensional stabilization and/or
10 desired mechanical properties of the final molded article.

Additional specific preferred methods, for the purposes of the present invention, for forming a polymer composite having dispersed therein exfoliated layered particles are disclosed in U.S. Patent Nos. 5,717,000, 5,747,560, 5,698,624, and WO 93/11190, each of which is hereby incorporated by reference. For additional
15 background, the following are also incorporated by reference: U.S. Patent Nos. 4,739,007 and 5,652,284.

Generally, compression molding processes are preferred for certain high volume production of reinforced plastics. Automotive interior trim parts produced by low pressure compression molding can be very complex with fine detail and close
20 dimensional tolerance. Thus, thin, reinforced molded-in inserts for screws, bearings, or other attachments in automotive trim may be produced by compression molding according to the invention. Reinforced bosses or other hollow circular standoffs into which a screw can be thread may be made as well. Reinforced bosses having small ribs for even greater reinforcement are also contemplated according to the invention.
25 Stiffening ribs may be integrally molded into automobile interior trim according to the

invention. Ribs forming hooks may be reinforced according to the invention. All such integrally molded, reinforced protruding elements have a thickness of less than 1/10 inch and extend from a primary trim portion or body.

Typical resins used in low pressure compression molding include nylon, polypropylene, thermoplastic polyester and polycarbonate. The process permits use of recycled materials, such as scrap polyolefins. Preferably, the thermoplastic used in the present invention is a polyolefin or a homogenous or copolymer blend of polyolefins. The preferred polyolefin is at least one member selected from the group consisting of polypropylene, ethylene-propylene copolymers, thermoplastic olefins (TPOs), and thermoplastic polyolefin elastomers (TPEs). For high performance applications, engineering thermoplastics are most preferred. Such engineering thermoplastic resins may include polycarbonate (PC), acrylonitrile butadiene styrene (ABS), a PC/ABS blend, polyethylene terephthalates (PET), polybutylene terephthalates (PBT), polyphenylene oxide (PPO), or the like.

The exfoliation of layered mineral particles into constituent layers need not be complete in order to achieve the objects of the present invention. The present invention contemplates that more than 50% of the particles should be less than about 20 nanometers in thickness. Otherwise stated, more than about 50% of the particles should be less than about 20 platelets stacked upon one another in the thickness direction. In addition, at least 99% of the particles should have a thickness of less than about 30 layers. Preferably, at least 90 % of the particles should have a thickness of less than about 5 layers. It is most preferable to have as many particles as possible to be as small as possible, ideally including only a single platelet. Particles having more than 30 layers may behave as stress concentrators and are preferably avoided, to the extent possible.

Generally, in accordance with the present invention, each of the automotive parts that can be manufactured in accordance with the principles of the present invention should contain nanoparticle reinforcement in amounts less than 15% by volume of the total volume of the part. The balance of the part is to comprise an appropriate thermoplastic material and optionally, suitable additives. If greater than 15% by volume of reinforcement filler is used, the viscosity of the composition becomes higher than what is desirable for molding. Preferably, the amount of reinforcing nanoparticles is greater than 2% by volume, as lower amounts would not achieve the desired increase in strength.

Preferably, relatively rigid compression molded trim parts having thin protrusions comprise reinforcement particles of the type described herein at about 2-15% of the total volume of the part, with the balance comprising the thermoplastic substrate. It is even more preferable for these interior panels to have reinforcement particles of the type contemplated herein comprising about 3%-8% of the total volume of the part. For some applications, inclusion of about 3%-5% by volume reinforcing nanoparticles is optimal.

When about 90% of the nanoparticles in the composition are less than 5 nm in thickness, a more preferred uniform distribution of the particles occurs in the resin, which translates into evenly distributed resin throughout the mold cavity. The extremely small size of these reinforcing particles permits them to fill thin mold cavity areas less than 1/10 inch thick without impairing resin flow. A reduction to near elimination of unreinforced protrusions occurs in the final molded product, accordingly.

In addition to reinforcing agents, other additives may optionally be included in the polymer composition to improve processability. For example, aging modifiers,

such as glycerol monostearate, are useful additives in polymer compositions for molding. Aging modifiers are typically present in an amount from about 0.5% to about 5% thermoplastic resin. Release agents may also be present to enhance removal of the final product from the mold. Other additives include pigments, heat stabilizers, antioxidants, flame retardants, ultraviolet absorbing agents and the like.

Reinforced articles of the invention exhibit improved properties over non-reinforced articles. For example, polyethylene articles having about 5% nanoparticles by volume, wherein 90% of the particles have 5 or fewer layers, increased flexural modulus by 2.5 to about 3 times over compositions lacking reinforcing nanoparticles, as measured under ASTM D790 test conditions. This 5% nanoparticle polyethylene article exhibited > 200% elongation to rupture. By contrast, about 25% glass fiber reinforcement is required in such articles to achieve an equivalent modulus. Polypropylene articles according to the invention showed about a 60% improvement in flexural modulus over articles lacking reinforcement nanoparticles. Thus, the use of reinforcing nanoparticles according to the invention provides articles having good flexural stiffness.

Fig. 4 is a partial perspective view, partly in section, and illustrating another application of the present invention. Specifically, Fig. 4 illustrates an article 70 having projections forming a boss 80. The article 70 may be a panel 10 as illustrated in Fig. 1, and boss 80 may be one of the bosses 16 illustrated in Fig. 1. The boss 80 is formed on a main portion 82 and defines a hole through the article 70. The protrusion 80 is integrally compression molded with main portion 82. The protrusion includes a cylindrical wall portion 84 and a plurality of radially projecting support ribs 86. The wall thickness of the projections is less than 0.1". For example, the wall thickness (t) of the cylindrical wall portion 84 is less than 0.1". The cylindrical wall portion 84

has a height (h) of at least twice the thickness (t). The height (h) is at least twice the thickness (a) of the main portion 82. The article 70 is compression molded from the same material specified with respect to the previous embodiment. The boss 80 is constructed and arranged to receive a fastener therethrough to fix a structure to article 70.

FIG. 5 illustrates another embodiment of the method in accordance with the present invention. In FIG. 5, a decorative material 90 is placed between the first die structure 22 and the second die structure 24 before the hot melt material 30 is introduced into the die cavity. The hot melt is then injected or poured onto the surface of the decorative material 90 and adhered thereto as a result of the curing process. In one embodiment the decorative material 90 is selected from flexible materials, that are calendared or embossed to provide a leather-like appearance. In such an embodiment, it is preferred that the decorative material be selected from a group consisting of vinyl, polyvinylchloride/acrylonitrile, butadiene, styrene (PVC/ABS), thermoplastic polyolefins (TPO), polypropylene (PP), and thermoplastic polyurethanes (TPU).

FIG. 6 illustrates yet another embodiment of the method in accordance with the present invention. In FIG. 6, a decorative material 90 is again placed between the first die structure 22 and the second die structure 24 before the hot melt material 30 is introduced into the die cavity. The hot melt is then injected or poured onto the surface of the decorative material 90 and adhered thereto as a result of the curing process. In this embodiment, the decorative material comprises a fabric, cloth, or carpeting layer 92 as an aesthetically appealing skin for the interior of the vehicle. The decorative material 90 further includes a second layer 94 which is a bonded foam layer and/or a film layer that provide a semi-soft feel and to keep molten plastic from penetrating into the fabric, cloth or carpeting layer 92.

It should be appreciated that the foregoing description is illustrative in nature and that the present invention includes modifications, changes, and equivalents thereof, without departure from the scope of the invention.

What is claimed is:

1. A reinforced molded article comprising:

a main portion having opposing major surfaces defining a thickness of said main portion;

a protrusion integrally molded with said main portion and protruding from one of said surfaces, said protrusion having a thickness of less than the thickness of said main portion and less than about 0.1", said protrusion having a height of at least twice the thickness of said protrusion,

said main portion and said protrusion being formed from a material comprising at least one thermoplastic, and about 2% to about 15%, by volume, reinforcing particles,

said particles each comprising one or more layers, at least 50% of said reinforcing particles being less than about 20 layers thick, at least 99% of said reinforcing particles being less than about 30 layers thick, and said layers comprising platelets having a thickness of between about 0.7 nm and 1.2 nm.

2. A reinforced molded article according to claim 1, further comprising a decorative material adhered to an opposite surface disposed on a side of said main portion opposite said one of said surfaces.

3. A reinforced molded article according to claim 2, wherein said decorative material is made from a material selected from a group consisting of vinyl, PVC/ABS, TPO, PP, and TPU.

4. A reinforced molded article according to claim 2, wherein said decorative material is made from fabric, cloth, or carpeting.

5. A reinforced molded article according to claim 4, wherein said decorative material further includes has at least one of a bonded foam layer and a film layer disposed in contact with said opposite surface.

6. A method of producing a reinforced article comprising a main portion having opposing major surfaces defining a thickness of said main portion, a protrusion integrally molded with said main portion and protruding from one of said surfaces, said protrusion having a thickness of less than the thickness of said main portion and less than about 0.1", said protrusion having a height of at least twice the thickness of said protrusion, said method comprising:

preparing a melt of at least one thermoplastic, and about 2% to about 15%, by volume, of reinforcing particles,

said particles each comprising one or more layers, at least 50% of said reinforcing particles being less than about 20 layers thick, at least 99% of said reinforcing particles being less than about 30 layers thick, and said layers comprising platelets having a thickness of between about 0.7 nm and 1.2 nm;

compressing said melt between die surfaces at a pressure of less than 3,000 PSI, said die surfaces having recesses corresponding to the shape of said protrusions,

receiving said melt, including said 2%-15% by volume reinforcing particles, in said recesses so that said melt conforms to the shape of said recesses;

cooling said melt, wherein cooled portions of said melt received in said recesses form said reinforced protrusions.

7. A method according to claim 6, further comprising:

placing a decorative material between said die surfaces and contacting said melt with said decorative material so as to adhere said decorative material to said melt.

8. A method according to claim 7, wherein said decorative material contacts a surface of said die cavity opposite said surface having said recesses.

9. A method according to claim 7, wherein said decorative material is made from a material selected from a group consisting of vinyl, PVC/ABS, TPO, PP, and TPU.

10. A method according to claim 7, wherein said decorative material includes a first layer made fabric, cloth, or carpeting, and a second layer comprising at least one of a bonded foam layer and a film layer disposed in contact with said first layer, said second layer contacting said melt between said die surfaces to prevent said melt from permeating through said first layer.

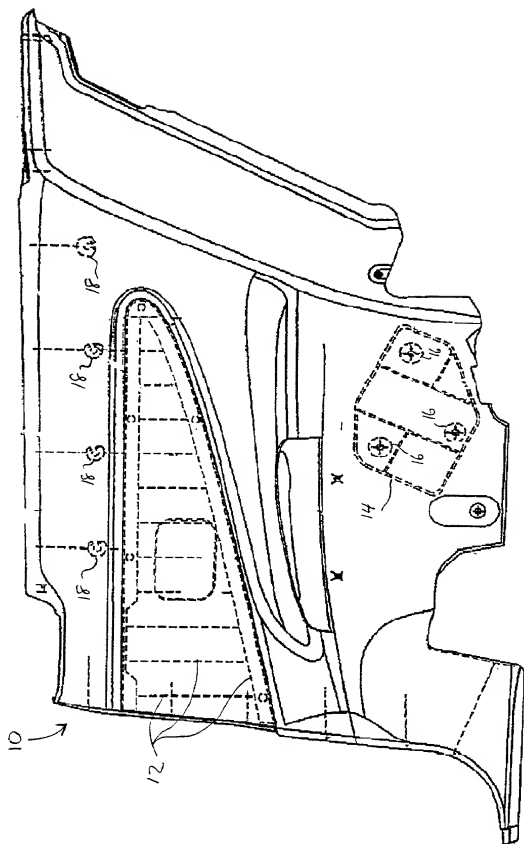
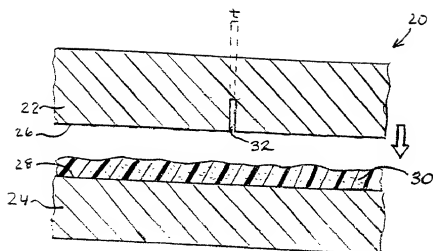
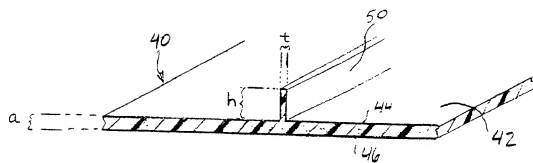


FIG. 1

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FIG. 2FIG. 3

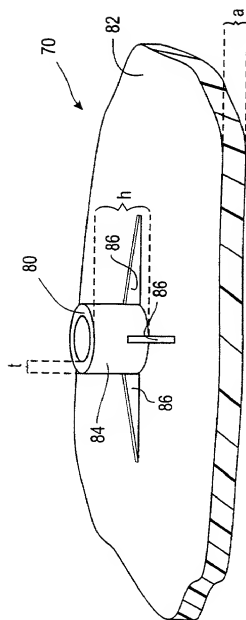
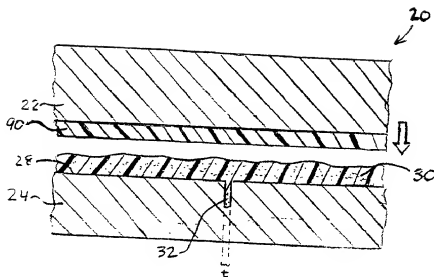
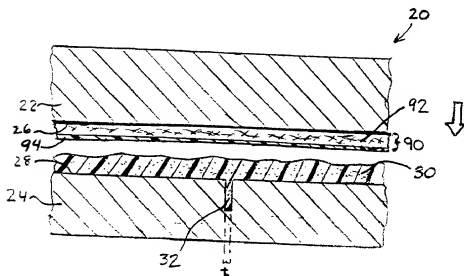


FIG. 4

FIG. 5FIG. 6

Docket No.
Dkt. 381REG

Declaration and Power of Attorney For Patent Application

English Language Declaration

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name,

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

Low Pressure Compression Molded Parts Having Nano- particle Reinforced Protrusions And Method of Making The Same

the specification of which

(check one)

☒ is attached hereto.

☐ was filed on _____ as United States Application No. or PCT International

Application Number _____

and was amended on _____

(if applicable)

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose to the United States Patent and Trademark Office all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, Section 119(a)-(d) or Section 365(b) of any foreign application(s) for patent or inventor's certificate, or Section 365(a) of any PCT International application which designated at least one country other than the United States, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate or PCT International application having a filing date before that of the application on which priority is claimed.

Priority Foreign Application(s)

Priority Not Claimed

(Number)

(Country)

(Day/Month/Year Filed)

☐

(Number)

(Country)

(Day/Month/Year Filed)

☐

(Number)

(Country)

(Day/Month/Year Filed)

☐

I hereby claim the benefit under 35 U.S.C. Section 119(e) of any United States provisional application(s) listed below:

60/113,133	12/21/98
(Application Serial No.)	(Filing Date)
_____	_____
(Application Serial No.)	(Filing Date)
_____	_____
(Application Serial No.)	(Filing Date)

I hereby claim the benefit under 35 U. S. C. Section 120 of any United States application(s), or Section 365(c) of any PCT International application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of 35 U.S.C. Section 112, I acknowledge the duty to disclose to the United States Patent and Trademark Office all information known to me to be material to patentability as defined in Title 37, C. F. R., Section 1.56 which became available between the filing date of the prior application and the national or PCT International filing date of this application:

(Application Serial No.)	(Filing Date)	(Status)
_____	_____	(patented, pending, abandoned)
(Application Serial No.)	(Filing Date)	(Status)
_____	_____	(patented, pending, abandoned)
(Application Serial No.)	(Filing Date)	(Status)
_____	_____	(patented, pending, abandoned)

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

09868945-062101

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith. (list name and registration number)

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